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ENTOMOLOGICAL NEWS

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Biological Notes on some Hymenoptera that Nest in Sumach Pith

By KARL V. KROMBEIN, Entomology Research Division, Agricultural Research Service, U. S. Department of Agriculture, Washington, D. C.

In 1958 I became interested in the wasps nesting in the soft pith of scrubby staghorn sumach (*Rhus typhina*) and smooth sumach (*R. glabra*) during an effort to elucidate the biology of *Chrysis* (*Ceratochrysis*) *enhuycki* Cooper and its host *Leptochilus republicanus zendaloides* (Robt.). The study on these two wasps has been reported (Krombein 1959). Information obtained on other Hymenoptera nesting in sumach pith is presented below.

The nests were obtained from sumachs growing along the right of way of the Washington and Old Dominion Railroad between Dunn Loring and Vienna in Fairfax County, Virginia. Some species burrowed into the soft pith of the stems or larger lateral branches with a diameter of 15 to 30 mm. Other species utilized pre-existing borings in the pith.

A few nests were obtained during examination of the sumachs on January 4, 1958, and March 7, 1959, but most of the nests were obtained during the summer of 1958. I topped several hundred stems and branches of smooth and staghorn sumach on June 17 in order to provide easily accessible entry to the pith. These particular sumachs were checked on July 1 and 15, August 15 and 28, September 3, 11, 19 and 26, and October 31, all stems that showed evidence of borings being gathered each date. The following notes were made from an examination of these borings and rearing of the occupants. Overwintering

nests were left outdoors from the end of October through March 1959, and were then brought into my office; emergence dates from these nests are therefore earlier than normal.

I am indebted to the following specialists for identification of prey or parasites obtained during this study: R. M. Bohart (*Omalus*); B. D. Burks (Symphyta and Chalcidoidea); H. W. Capps (Lepidoptera); R. H. Foote (Diptera, in part); L. M. Russell (Aphidae); C. W. Sabrosky (Diptera, in part); A. Stone (Diptera, in part); H. K. Townes (Ichneumonidae); and W. W. Wirth (Diptera, in part). My daughters, Kristin and Kyra, assisted in hunting for the nests.

Hemitaxonus dubitatus (Norton)

Larvae of this small tenthredinid sawfly pupate in borings. I believe that they probably utilize abandoned borings rather than chewing out their own, because at least one of them was at the bottom of a boring 78 mm. long. The sawfly does not spin a cocoon, but constructs a narrow plug of fine particles of pith just above itself, and occasionally also beneath itself. It does not construct a plug at the boring entrance. In one case a species of *Passaloecus* constructed a one-celled nest above the sawfly retreat. Sawfly prepupae were found in stems picked up on September 11 and 26 and October 31. Larvae of this sawfly have been recorded as feeding on *Osmunda*. However, in the locality of my research I suppose that they feed on bracken (*Pteridium*) which is common along the railroad tracks. I was successful in rearing one male sawfly (92658 D) from the few available prepupae. It pupated between April 6 and 10, and emerged on April 13.

An ichneumonid, *Cubocephalus canadensis* (Prov.), was reared from a prepupa of this sawfly (103158 E) found on October 31. The parasite had spun its cocoon inside the sawfly retreat. It transformed to a pupa on April 8, and a male emerged on April 15. Another sawfly prepupa (91158 C) found on September 11 had a slender parasite egg next to it. This egg was 1.54 mm. long and 0.28 mm. wide across the middle. It was adjacent to the thoracic legs but was not glued

to the body. It may have been an egg of *Cubocephalus,* but unfortunately it failed to hatch.

Perithous mediator pleuralis Cresson

Four males of this ichneumonid were reared from a nest (92658 B) of a species of *Pemphredon,* probably *harbecki* Roh. This nest was in a stem of staghorn sumach. The boring was 2.5 mm. wide and sinuous. It was about 32.5 cm. long with the upper 13 cm. empty except for a plug of particles of fine pith 15 mm. thick located 9 cm. from the entrance. Some of the cells were in separate pockets separated from the main boring by a plug of fine particles of pith; other cells were in a linear series in the main boring and were separated by a few millimeters of pith particles. This nest architecture is characteristic of *harbecki* rather than of *lethifer,* the other species of *Pemphredon* which nests in sumach pith in this area.

When this nest was picked up on September 26, each of two cells contained small black meconial pellets of the *Pemphredon* larva and a small larva of *Perithous* feeding on the full grown wasp larva. Another cell contained a chrysidid prepupa, probably of a species of *Omalus,* in its cocoon. I preserved a mature wasp larva and samples of the aphid prey. The aphids were identified as *Rhopalosiphum rhois* Mon.; most of them were wingless.

On September 29 a small parasite larva was feeding on the chrysidid prepupa mentioned above. The other *Perithous* larvae, which had been feeding on the *Pemphredon* larvae, were now full grown and beginning to spin cocoons. The cocoons were completed a couple of days later and were of very delicate silken mesh. Four males of *Perithous mediator pleuralis* emerged from this nest on April 13, 14, and 16, and two males of *Omalus sinuosus* Auctt. on April 11 and 13, and one female of the *Omalus* on April 13. All cells of the host wasp were parasitized.

Reinhard (1929) reared *pleuralis* from nests of *Pemphredon concolor* Say in an old beech stump.

Cubocephalus canadensis (Provancher)

A male of this ichneumonid was reared from a prepupa of the tenthredinid sawfly *Hemitaxonus dubitatus* (Norton), *q. v.*

Perilampus canadensis Crawford

Two specimens of this perilampid emerged from cocoons of the sphecid *Ectemnius stirpicola* (Pack.), *q. v.*

Diomorus zabriskiei Cresson

Several specimens of this torymid were bred from cocoons of *Ectemnius stirpicola* (Pack.), *q. v.*

Habritys latro Wallace

Adult females of this pteromalid were found in nests of *Ectemnius stirpicola,* and a few were reared from cocoons of this wasp, *q. v.*

Epistenia coeruleata Westwood

This pteromalid is parasitic on prepupae of the vespid *Leptochilus republicanus zendaloides* (Robt.) nesting in sumach (Krombein 1959).

Axima zabriskiei Howard

This eurytomid was reared from prepupae of the apid *Ceratina calcarata* Robt., *q. v.*

Omalus (Omalus) sinuosus Auctt.[1]

This chrysidid was reared from *Pemphredon lethifer* (Shuck.), *q. v.,* and probably also from *P. harbecki* Roh. (see notes above under *Perithous mediator pleuralis* Cr.).

The cocoons are spun of semitransparent white silk and range from 4.6 to 5.1 mm. long. They are circular in cross section;

[1] This species has been misidentified as *sinuosus* (Say), 1828. It will be described as a new species by Bohart and Campos in a forthcoming revision.

the tail end is rounded and the head end truncate. Unlike the cocoons of some other species of *Omalus,* the head end of the cocoon of *sinuosus* Auctt. is no thicker than the walls, and is not composed of strands of silk spun in a fine, close spiral pattern.

Chrysis (Ceratochrysis) enhuycki Cooper

This chrysidid is a social parasite of the vespid *Leptochilus republicanus zendaloides* (Robt.) nesting in sumach (Krombein 1959).

Leptochilus republicanus zendaloides (Robertson)

Biological notes on this vespid, which nests in sumach, and its parasites were reported earlier (Krombein 1959).

Stenodynerus (Parancistrocerus) perennis perennis (Saussure)

One nest (3759 B) of this vespid was found in a stem of staghorn sumach on March 7, 1959. On this date it contained vespid prepupae in frail, light tan, silken cocoons lining the cell walls. The nest was constructed in the upper end of a long pre-existing boring in the pith. The boring was 3–3.5 mm. in diameter and was closed off 35 mm. from the upper end by an earthen plug 3 mm. thick, constructed presumably by the mother *perennis.* Above this plug were three cells, 11, 11, and 13 mm. long, capped by earthen partitions 1 mm. in thickness. The lepidopterous remains in the cells were identified as mostly larvae of Blastobasidae and a few fragments of larvae of another family. One of the prepupae pupated between March 11 and 16, and an adult female of *p. perennis* emerged on March 30.

Rau (1935) also found typical *perennis* nesting in twigs, the cells separated by clay partitions. Krombein (*in* Krombein and Evans 1955) found *perennis anacardivora* (Roh.) also nesting in a twig and provisioning its cells with larvae of Olethreutidae and Gelechiidae.

Pemphredon (Cemonus) harbecki Rohwer

Two females of this sphecid wasp were recovered from the paper sacks in which I transported the stems from Dunn Loring to my office on August 28 and September 26. A third female (82858 B) was found, head outward, at the bottom of an otherwise empty boring in a stem of smooth sumach 6 mm. in diameter. The boring was 16 cm. long and 3 mm. in diameter. A nest, possibly belonging to this wasp, was described under *Perithous mediator pleuralis, q. v.* The aphid prey stored in this nest was *Rhopalosiphum rhois* Mon. All cells were parasitized by *Perithous* or by *Omalus sinuosus* Auctt. The type series of *harbecki* was reared from a nest in pith of elder (*Sambucus*).

Pemphredon (Cemonus) lethifer (Shuckard)

Two females of this species were recovered on September 11 and 19 from the paper sacks used for transporting stems on those dates.

One nest of *lethifer* (91958 C) was found in a stem of smooth sumach 7 mm. in diameter on September 19. This nest was not completely stored, and may have belonged to the female found loose in the paper sack. The boring was 150 mm. long and 2.5 mm. in diameter. The upper end was empty for 40 mm. Below this empty space were tightly packed aphids for 7 mm., then in succession a wasp egg placed across the boring, 12 mm. of tightly packed aphids and a small wasp larva, two full-grown wasp larvae devouring the last of the aphids provided for them, scattered small particles of pith for 15 mm., a large wasp larva beginning to spin its cocoon, and several prepupae in cocoons. The lower end was filled with fine particles of pith for 20 mm. The aphids were purple nymphs, 0.75–1.25 mm. long of a species of *Aphis*. The cocoons were 9–10 mm. long, and consisted of a silken cap above and a partition of tougher silk at the lower end which walled off the meconial pellets. Several of the prepupae and mature larvae were preserved for taxonomic study. The remaining prepupae pupated between April 1 and

6. Three males of *lethifer* left the boring on April 14, 15, and 16, and one female on the 17th.

Another nest (DL 3) was found in a stem of smooth sumach 9 mm. in diameter on January 4, 1958. This boring was sinuous, 2 mm. in diameter, and was closed by a plug of fine particles of pith. It contained several *Pemphredon* prepupae, and at the inner end two chrysidid cocoons, 6 and 4.5 mm. long, with aphid remains attached to the cocoons. Males of *lethifer* emerged on April 22 and 23, and a male of *Omalus sinuosus* Auctt. on the 24th. The other *Omalus* died as a fully colored pupa.

Rau (1948), referring to this species as *inornatus* Say, published a few notes on its biology. He found it nesting in hollow stems of *Weigelia* and provisioning with *Aphis gossypii* Glov.

Passaloecus annulatus (Say)

A nest of this sphecid wasp (92658 C) was found in a stem of smooth sumach 8–10 mm. in diameter on September 26. The boring was sinuous, 20 mm. long and 2 mm. in diameter. There was a thin plug of resin at the entrance. Beneath this were two cells 11 and 9 mm. in length separated by thin partitions of resin. The cells were stored with tightly packed aphid nymphs belonging to a species of *Macrosiphum*. A small wasp larva was present in each cell. Both larvae were nearly full grown on September 29, and spun their cocoons the next day. The cocoon consisted of just a delicate silken cap at the upper end of the cell spun adjacent to the resin partition. The meconium was voided as a long black ribbon. One of the larvae had deposited the meconium at the upper end of the cell next to the silken cap, and had then spun another silken cap beneath the meconium. One of the prepupae was preserved for taxonomic study. The other pupated a few days before March 31. It became fully colored but failed to eclose. It was readily identifiable as a male of *annulatus*.

Another nest (92658 D), found in smooth sumach on the same date, was probably a nest of *annulatus* also. It consisted of a single cell constructed in 20 mm. of boring above a pupation chamber of the sawfly *Hemitaxonus dubitatus*. The cell was

13 mm. long and was capped by a thin partition of resin. There was an empty space of 6 mm. above the cell and then a thin closing plug of resin at the boring entrance. The wasp egg was injured when I opened the stem. The cell contained 26 tightly packed, pale green aphid nymphs, 1.3–2.5 mm. long, of the same species of *Macrosiphum* stored in the other nest of *annulatus*.

Krombein (1955, 1958) reported *annulatus* as nesting in deserted anobiid burrows in structural lumber and provisioning with nymphs of *Drepanaphis* sp., probably *acerifoliae* (Thos.) and *Macrosiphum* sp.

(*To be continued*)

Nomenclature Notice

All comments relating to the following should be marked with the Commission's File Number and sent in duplicate, before March 1st to W. E. China, Assistant Secretary, International Commission on Zoological Nomenclature, c/o British Museum (Natural History), Cromwell Road, London, S.W. 7, England.

Designation of a type species for the nominal genus **Bolitochara** Mannerheim, 1831 (Class Insecta, Order Coleoptera). Z.N.(S.) 243.

Designation of type species for the nominal genera **Ischnopoda** Stephens, 1835, and **Tachyusa** Erichson, 1837 (Class Insecta, Order Coleoptera). Z.N.(S.) 244.

For details see Bull. Zool. Nomencl. Vol. 17, Parts 3/5.

The Feeding and Culturing of Orthoptera in the Laboratory

By S. K. GANGWERE

(*Continued from p. 13*)

WALKING-STICKS (PHASMIDAE)

The nocturnally active walking-stick *Diapheromera,* which is probably typical of a number of phasmids, is readily maintained in the laboratory. The same cage set-up as described for grasshoppers is used, but the food requirements differ markedly. It is restricted, at least in the adult stage, to the leaves of various trees and shrubs, including *Hamamelis, Quercus, Prunus, Rubus, Tilia,* and *Ulmus,* and refuses lettuce and other laboratory foods. The young nymphs are known to accept leaves of *Tilia,* and the author believes that they may eat those of *Rubus. Diapheromera* adults do not need a supply of water, although the nymphs benefit from a daily, light sprinkling with water from an atomizer.

The eggs of *Diapheromera* are dropped carelessly on the floor of the cage, where, as pointed out by Graham ('37), they can be collected and placed in gauze-capped vials until hatching. Mortality of the newly hatched is heavy. During hatching and molting the young should have access to slightly moistened sand.

CRICKETS (GRYLLIDAE)

Michigan ground crickets (Nemobiinae) and field crickets (Gryllinae), which are largely nocturnal insects, are kept in a grasshopper cage or in a battery jar. If the latter, its opening is closed with a weighted piece of window screening or with a piece of cheesecloth held to the jar rim with rubber bands. The floor is covered with dry sand. Some kind of shelter and perching space is desirable; this may be a small quantity of excelsior or an inverted paper cup with notches cut in the mouth edge, but the author prefers, for ease of observation, small tiers made of a number of horizontal strips of pressed board, aligned

parallel to one another and nailed to wooden end pieces, leaving ½-inch gaps between them. One such tier is placed in a cage. While the cage need not be kept in a darkened place it should be kept in subdued light.

Ground and field crickets are scavengers; thus, almost any food is satisfactory. They thrive on lettuce, slices of various fruits, crushed dog biscuits, chicken mash, peanut butter, cheese, meat scraps, and laboratory rations, *e.g.*, Haydak's mixture. They eat both bran and oat flakes but prefer the latter. Their food is placed in a petri dish or is thrown on the floor. They obtain water from their food unless a dry type is used, making necessary a water vial.

Adult ground and field crickets breed readily when their cage contains a finger bowl filled with damp sand. After they have oviposited, the eggs are left in the original cage or are removed to a new one, where hatching and molting of the nymphs occur.

White tree crickets (Oecanthinae) are more difficult to maintain for long periods of time than are other Michigan crickets. These largely nocturnal insects are kept in a grasshopper cage, where they are provided with one or more native food-plants, including leaves and flowers of *Aster, Daucus, Linaria, Rudbeckia,* and *Solidago.* On occasion they should also be given lettuce, pieces of various fruits, and small prey, *e.g.,* aphids. While they do not require drinking water, they appear to benefit from the humidity of an occasional, light sprinkling with water from an atomizer. Laboratory rearing is accomplished only after some difficulty, for the appropriate host plant is needed for oviposition. Fulton ('15) has described the oviposition habits of certain species.

Cockroaches (Blattidae)

The nocturnally active cockroaches are the easiest to rear of all the Michigan Orthoptera. Most species are readily maintained in a battery-jar container such as described for crickets, but some demand unusually great humidity. The inner edge of the jar is lightly smeared with vaseline and the opening closed with weighted window screening or, better, the edge is

not smeared but is capped with a glass plate, to prevent the insects' escape. This latter set-up maintains a high humidity, but a small piece of dampened sponge will probably be needed to increase it. The floor of the cage may be covered with excelsior or with wadded paper, but observation is facilitated if dry sand is used, together with a perching tier, such as described for crickets. The cage is always kept in subdued light or in darkness.

Food is no problem, for these scavengers eat virtually anything from human foodstuffs to paper, being especially fond of amylaceous foods. They eat lettuce, slices of various fruits and potato, crushed dog biscuits, chicken mash, peanut butter, cheese, meat scraps, bran and oat flakes, and laboratory rations. They can survive on the water in their foods but do best when given a continuous supply in water vials.

Rearing of cockroaches in the laboratory is easily accomplished, for if adult males and females of a species are caged together egg capsules or oöthecae are the inevitable result, except in the case of ovoviviparous forms. For a time interval characteristic of the species, these are carried about by the females and then dropped. Once dropped, they are allowed to develop on the floor of the original cage or are placed in a new one, where hatching occurs. The nymphs mature without difficulty if they have sufficient food and warmth.

Camel Crickets (Gryllacrididae: Rhaphidophorinae)

Michigan camel crickets, like most cockroaches, are noctural scavengers requiring shelter, darkness, and high humidity. Consequently, they can be maintained under essentially the same conditions as cockroaches and in the same kind of cage, but the sand is removed to prevent them from burrowing beneath it. The cage is kept in subdued light or in darkness and always contains a small piece of dampened sponge to moisten its air. Though omnivorous, camel crickets do not have quite the latitude in their feeding as do cockroaches. Nevertheless, they will eat lettuce, bran and oat flakes, pieces of various fruits, meat scraps, peanut butter, and cheese. As reported by Hubbell ('37),

they can be induced to oviposit in a finger bowl containing moist sand, in which their eggs will develop. This dish is kept in the cage for a time after hatching to assure a high humidity, for the young are especially delicate.

Grouse Locusts (Tetrigidae)

Grouse locusts, like their grasshopper relatives, are diurnal, but their cage requirements are quite different from those of any other orthopteran. Most Michigan species can be maintained in a grasshopper cage, but the floor is covered with moist sand or, better, with the moist organic soil of their habitat, together with its covering of lower plants. The sand does not mold as readily as the soil but is inferior in that it does not grow the animals' food. Whatever the floor covering, it is kept moist but not wet. A few pieces of bark are suitable for perches. The grouse locusts' food consists of algae, molds, mosses, and sprouts of grasses and herbs. Lettuce is a convenient laboratory food. Various laboratory-grown algae may also be used for this purpose. A vial of drinking water is unnecessary. Grouse locusts oviposit in the soil but, as indicated by Nabours ('37), are difficult to rear successfully.

Praying Mantids (Mantidae)

Mantids are easy to rear but are somewhat more trouble to house and to feed. The cannibalistic adults and older nymphs are kept separately in small screen cages of design similar to that of the author's grasshopper cages; these use standard fruit jar lids as roof and floor. Small groups of young nymphs may be placed together in gauze-capped vials but are most safely handled and fed when housed individually. An appropriate-sized perch, either a small strip of paper (for vials) or a larger strip of cardboard or a twig (for cages), is placed in each container. The cages are always kept in a well-lighted place but should be sheltered from strong sunlight.

Mantids are predacious. The younger nymphs eat small, soft-bodied insects such as aphids and fruit flies; the older ones

eat larger insects such as houseflies and nymphal grasshoppers; and the adults eat large mealworms, grasshoppers, cockroaches, etc. Because of their voracious appetite mantids should be fed often. They do not require a supply of water.

To rear mantids, a male and a female are caged together, copulation ensuing. The males are sometimes eaten by the larger females during this time. The eggs are deposited in oöthecae, which are fixed to the twigs in the cages, where they hatch without additional care. Young are placed immediately in vials, sprinkled with water from an atomizer, and given prey. Nevertheless, early mortality is great.

Acknowledgments

Dr. Irving Cantrall, of the University of Michigan Museum of Zoology, who is a person of long-time acquaintance with the Orthoptera, contributed both encouragement and sound advice during the course of the foregoing maintenance and rearing studies. His assistance was instrumental in solving a number of technical problems. Drs. Cantrall, Alfred Beeton, of the U. S. Fish and Wildlife Service, and Henry Townes, of the University of Michigan Museum of Zoology, critically reviewed the manuscript. To these biologists the author is deeply indebted.

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REFERENCES TO THE CULTURE OF ORTHOPTERA

While there is no great body of information available on the maintenance and rearing of Orthoptera, there are several papers pertaining to most groups and a large number to three of them, the grasshoppers, crickets, and cockroaches, especially the latter. These are relatively difficult to find, being widely scattered throughout numerous journals and usually composing but incidental parts of larger studies. It would appear that a compilation of papers of this type would have considerable usefulness. The following therefore, is a list of the more useful of the numerous such works the author has perused:

General Interest:

CAMPBELL, F. L., and F. R. MOULTON. 1943. Laboratory procedures in studies of the chemical control of insects. A. A. A. S. Publ. No. 20: 206 pp. (Equipment; rearing of cockroaches and various non-orthopterans.)

NEEDHAM, J. G., *et al.* 1937. Culture methods for invertebrate animals. Comstock Publ. Co.: 590 pp. (Rearing of cockroaches, mantids, camel crickets, crickets, grasshoppers, grouse locusts, and numerous non-orthopterans.)

PETERSON, A. 1934. A manual of entomological equipment and methods, Part I. Edwards Bros.: 21 + xiii pp., 138 pls. (Numerous cages and other types of equipment.)

——. 1937. A manual of entomological equipment and methods, Part II. John S. Swift Co.: 334 pp. (Abstracts of papers on rearing of various insects, including some orthopterans.)

——. 1953. A manual of entomological techniques. Edwards Bros.: 367 pp. (Equipment; rearing of grasshoppers, cockroaches, house crickets, and numerous non-orthopterans.)

Grasshoppers:

ALBRECHT, F. O. 1953. The breeding of the red locust in captivity. Bull. Ent. Res., 44: 1–4.

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Additional Records of Ectoparasites on Delaware Mammals [1]

By OTTO FLORSCHUTZ, JR., and RICHARD F. DARSIE, JR.[2, 3]

In 1945, MacCreary (1945a) published a list of ectoparasites taken from Delaware mammals. The present study is a follow-up of his original effort offering additional information on parasites of five mammalian hosts.

Other records of Delaware ectoparasites have been published by Ewing (1938) who listed *Myobia musculi* Schrank from *Mus musculus* L. (collected by H. S. Peters, Ft. DuPont, Delaware City; IV–13–33); Holland (1950), who reported on a Ceratophyllid flea from the State; MacCreary (1945b) and Darsie and Anastos (1957), who recorded Ixodidae from Delaware; MacCreary and Catts (1954), who worked on poultry parasites; and Scanlon and Johnson (1957), who referred to Polyplacine lice from this State.

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[3] The authors are indebted to Dr. Edward W. Baker and Dr. Phyllis T. Johnson, U. S. National Museum, Washington, D. C., for assistance in identification of mites and lice, respectively.

Procedure

All hosts were captured alive in boxtraps during the winter of 1958. The rodents were sacrificed and enclosed in pint-sized ice cream cartons for 24 hours, then the parasites were picked from host and carton and preserved in 70 per cent alcohol. Additional specimens were recovered by brushing with a leaf brushing machine developed by Henderson and McBurnie (1943). The larger mammals were caught during a rabbit trapping and transplanting program conducted by the Delaware Board of Game and Fish Commissioners. They were necessarily examined alive. There was no attempt to collect all the parasites from the rabbits.

Representative parasites from each animal were selected and mounted for study.

Results

The following mammals, common in Delaware, were examined for ectoparasites: meadow mouse, *Microtus pennsylvanicus* (Ord), house mouse, *Mus musculus* Linné, deer mouse, *Peromyscus leucopus* (Rafinesque), cottontail rabbit, *Sylvilagus floridanus* (Allen), and opossum, *Didelphis virginiana* Kerr. Although only 28 specimens were inspected, a total of 1142 parasitic arthropods were recovered. Even so, not all the parasites were removed from all hosts. Table 1 lists the number of hosts parasitized by each of the arthropod orders. The meadow mice were by far the most heavily infested, and likewise had the largest number of species.

About one-fourth of the ectozoans were identified to species. They are tabulated in table 2, along with their hosts. The known Delaware records and a discussion of the ectoparasite species follow.

Acarina

Haemolaelaps glasgowi (Ewing)

Newark, New Castle Co., ex *Microtus pennsylvanicus*, III–26–58, 2 ♀♀; III–27–58, 3 ♀♀; III–28–58, 3 ♀♀; IV–17–58,

3 ♀♀; ex *Peromyscus leucopus,* IV–3–58, 1 ♀ (O. Florschutz). MacCreary (1945a) listed this species under the genus *Atricholaelaps.* In addition to the above hosts, he named *Blarina brevicauda* (Say) and *Pitymys pinetorum pinetorum* (Lec.). This is probably the most widely distributed parasitic mite both geographically and in terms of numbers of hosts; see Strandtmann (1949), Baker et al. (1956), Hays and Guyton (1958) and Allred (1958). It has been reported from Africa by Zumpt and Till (1956).

TABLE 1. Number of Parasites Taken from Each Mammalian Host, Delaware, 1958

Host	Number Examined	Acarina		Anoplura		Siphonaptera	
		No. Hosts Infested	Total Number	No. Hosts Infested	Total Number	No. Hosts Infested	Total Number
Microtus pennsylvanicus	11	11	672	10	232	1	1
Mus musculus	3	1	10	0		0	
Peromyscus leucopus	1	1[1]	100	0		0	
Sylvilagus floridanus	11	0		0		11[1]	126
Didelphis virginiana	2	0		0		1	1
Total	28	13	782	10	232	13	128

[1] Not all the ectoparasites were removed from these hosts.

Haemolaelaps spp.

Newark, New Castle Co., ex *Microtus pennsylvanicus,* III–17–58, 1 nymph (O. Florschutz). Specific identification was not possible due to its immaturity.

Listrophorus spp.

Newark, New Castle Co., ex *Microtus pennsylvanicus,* III–27–58, 4 ♀♀; III–31–58, 2 ♀♀; ex *Peromyscus leucopus,* IV–3–58, 1 ♀. This mite genus has never before been reported from Delaware.

Laelaps alaskensis Grant

Newark, New Castle Co., ex *Microtus pennsylvanicus,* III–10–58, 4 ♀♀, 3 ♂♂; III–17–58, 4 ♀♀, 1 ♂; III–26–58, 6 ♀♀,

2 ♂♂; III–27–58, 6 ♀♀, 1 ♂; III–28–58, 6 ♀♀, 1 ♂; III–31–58, 3 ♀♀, 1 ♂; IV–5–58, 8 ♀♀; IV–17–58, 2 ♀♀; ex *Peromyscus leucopus,* IV–3–58, 7 ♀♀ (O. Florschutz). This is a new record for Delaware, but may have been included in the *Laelaps* spp. of MacCreary (1945a). It was one of the commonest mites on the meadow mice. The identification key of Pratt and Lane (1953) was useful in separating the two species of *Laelaps.*

Laelaps kochi Oudemans

Newark, New Castle Co., ex *Microtus pennsylvanicus,* III–10–58, 1 ♀; III–17–58, 3 ♀♀, 1 nymph; III–26–58, 4 ♀♀, 1 nymph; III–27–58, 3 ♀♀, 1 ♂; III–28–58, 2 ♀♀; III–31–58, 1 ♀, 2 ♂♂; IV–5–58, 9 ♀♀, 2 ♂♂; IV–17–58, 2 ♀♀ (O. Florschutz). This species was reported from Delaware by MacCreary (1945a) under the name *Laelaps microti* (Ewing). The role of this mite as a possible natural vector of tularemia was suggested by Grzhebina (1939).

Radfordia affinis (Poppe)

Newark (Cowentown), New Castle Co., ex *Mus musculus,* IV–3–58, 4 ♀♀, 2 ♂♂ (O. Florschutz). This is likewise a new Delaware mite record. This mite was the only one taken from *M. musculus,* despite thorough examination of the host. Ewing (1938) stated that he examined house mice from Delaware and failed to find this species.

ANOPLURA

Hoplopleura acanthopus (Burmeister)

Glasgow, New Castle Co., ex *Microtus pennsylvanicus,* VI–7–39, 3 ♀♀, 1 ♂ (D. MacCreary); Newark, New Castle Co., ex house mouse, VI–28–39, 1 ♂ (E. J. Gerberg); ex *M. pennsylvanicus,* III–10–58, 1 ♀, 2 ♂♂; III–17–58, 4 ♀♀, 2 ♂♂; III–26–58, 7 ♀♀, 1 ♂; III–27–58, 12 ♀♀; III–31–58, 1 ♀, 3 ♂♂; IV–5–58, 4 ♀♀, 4 ♂♂ (O. Florschutz). This is the most common rodent louse found in Delaware. It was also recorded

from *Peromyscus leucopus* and *Mus musculus* in Delaware by MacCreary (1945a). The ecology of this louse was discussed by Cook and Beer (1955). It is interesting to note that, in large samples taken in Minnesota, they never found *H. acanthopus* on deer mice of the genus *Peromyscus.* Conversely, *Hoplopleura hesperomydis* (Osborn) was the *Peromyscus* louse and never found on voles of the genera *Microtus* and *Clethrionymys,* the hosts of *H. acanthopus.*

TABLE 2. List of Ectoparasites Collected in New Castle County, Delaware, 1958, and Their Hosts

Parasite	Host Species				
	Microtus pennsylvanicus	*Mus musculus*	*Peromyscus leucopus*	*Sylvilagus floridanus*	*Didelphis virginiana*
ACARINA					
Haemolaelaps glasgowi	11		1		
Haemolaelaps spp.	1				
Laelaps alaskensis[1]	48		7		
Laelaps kochi	32				
Listrophorus spp.	6		1		
Radfordia affinis[1]		6			
ANOPLURA					
Hoplopleura acanthopus	41				
Polyplax alaskensis	2				
SIPHONAPTERA					
Cediopsylla simplex				109	
Megabothris asio asio	1				
Odontopsyllus multispinosus[1]				1	
Oropsylla arctomys					1
Total	142	6	9	110	1

[1] New records for Delaware.

Polyplax alaskensis Ewing

Newark, New Castle Co., ex *Microtus pennsylvanicus,* III–28–58, 1 ♀; III–31–58, 1 ♂ (O. Florschutz). The male was associated with *H. acanthopus,* while the female was the only louse found on its host. Although this species was not found by MacCreary (1945a), it was recorded from Delaware by Scanlon and Johnson (*loc. cit.*) but without any locality data.

It is interesting to note that Beer and Cook (1958), in a study of lice on *Peromyscus* in Oregon, found one species each

of *Hoplopleura* (*hesperomydis*) and *Polyplax* (*auricularis* Kellogg and Ferris), and in about the same ratio as in the present study, i.e., the former was much more abundant.

SIPHONAPTERA

Cediopsylla simplex (Baker)

Masten Corners, Kent Co., ex rabbit, VI–22–39, 1 ♀ (D. MacCreary); Newark, New Castle Co., ex *Sylvilagus floridanus,* I–17–58, 3 ♀♀, 2 ♂♂; I–18–58, 2 ♀♀, 1 ♂; I–20–58, 7 ♀♀, 2 ♂♂; I–22–58, 3 ♀♀, 7 ♂♂; I–24–58, 21 ♀♀, 10 ♂♂; II–1–58, 7 ♀♀, 2 ♂♂; II–4–58, 5 ♀♀, 3 ♂♂; II–11–58, 7 ♀♀, 7 ♂♂; II–12–58, 3 ♀♀, 7 ♂♂; IV–8–58, 5 ♀♀, 5 ♂♂ (O. Florschutz). This flea was found in great abundance on all rabbits examined. From 5 to 20 fleas were collected per animal. MacCreary (1945a) listed this species on *Marmota monax monax* (L.) but not on rabbit; the above data apparently serve as a new host record for Delaware. *C. simplex* was found to be most numerous among the New Jersey Siphonaptera, by Burbutis (1956).

Megabothris asio asio (Baker)

Delaware City, New Castle Co., ex *Microtus pennsylvanicus,* V–20–39, 1 ♂ (D. MacCreary); Camden, Kent Co., ex *M. pennsylvanicus,* VI–25–39, 1 ♂ (R. Traub); New Castle, New Castle Co., ex meadow mouse, VII–29–39, 1 ♂ (D. MacCreary); Newark, New Castle Co., ex *M. pennsylvanicus,* IV–4–58, 1 ♀ (O. Florschutz). MacCreary (1945a) registered it from Delaware. The first two records given above were published by Holland (1950). He also figured parts of a female from New Castle, Delaware (see his fig. 2).

Odontopsyllus multispinosus Baker

Newark, New Castle Co., ex *Sylvilagus floridanus,* I–20–58, 1 ♀ (O. Florschutz). This is a new Delaware flea record. Only a single female was collected in 110 rabbit fleas. The species

was found to be the second most common flea on rabbits in New Jersey by Burbutis (1956).

Oropsylla arctomys (Baker)

Yorklyn, New Castle Co., ex ground hog, VI–1–39, 1 ♀ (D. MacCreary); Newark, New Castle Co., ex *Didelphis virginiana,* III–7–58, 1 ♀ (C. Florschutz). The latter is a new host record for Delaware and appears to be a rare host relationship. According to Jellison and Good (1942), the first to report it was Jordan (1928) from Ligonier, Westmoreland Co., Pennsylvania. Fox (1940) included it as a host of *D. virginiana* in his host index. Recently Hamilton (1958), in a study of the life history and economic relations of the opossum in New York State, noted that this flea was recovered from a few individuals, but it was not nearly so abundant as on woodchucks.

Summary

During the winter of 1958, 28 small mammals were live-trapped in the vicinity of Newark, Delaware, and examined for ectoparasites. Five species of hosts were captured: *Microtus pennsylvanicus, Mus musculus, Peromyscus leucopus, Sylvilagus floridanus,* and *Didelphis virginiana.* A total of 1142 parasites was recovered and 268 of them were mounted and identified. The rodent hosts were sacrificed and stored in individual pint containers for 24 hours. The detached parasites were then collected and preserved in 70% alcohol. Additional parasites were collected by vigorous brushing. From the other hosts, specimens were picked off by hand. During this study, there were identified 113 mites of 6 species, 43 lice of 2 species, and 112 fleas of 4 species. Two of the mites, *Laelaps alaskensis* Grant, and *Radfordia affinis* (Poppe), and one flea, *Odontopsyllus multispinosus* Baker, are new records for Delaware.

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